

Method for producing plastic rods

The invention relates to a process for extrusion of round rods composed of transparent plastics, such as polymethyl methacrylate (PMMA), polycarbonate (PC), or (PET) polyethylene.

Round rods composed of Plexiglas[®] are known, and are marketed by Röhm GmbH & Co. KG.

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The production of these rods can be regarded as complicated, depending on requirements. In known methods, a flat sheet composed of PMMA is first produced, and is divided into pieces to give square rods. The square rods are then subjected to mechanical working (turning and polishing). This process is labor-intensive and therefore of no great commercial interest, especially since it also generates a corresponding amount of waste. The price level for round rods of this type is relatively high. Another process consists in the casting of rods, but this is likewise complicated and of rather low commercial significance.

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Good-quality round rods with relatively small diameters can be obtained via extrusion of a PMMA molding composition, such as Plexiglas[®] 7H.

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However, the technology of this process makes it difficult for rods from about $D = 25$ mm, because since a large amount of thermal energy has to be dissipated from the extruded rod via cooling, adequate dimensional stability cannot be achieved until some time has elapsed, and a resultant disadvantage is that flexing can occur. This effect can be countered by applying suitable cooling sections, e.g. cooling air, in combination with support rollers.

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However, both of these measures are disadvantageous

because the rod collapses under its own weight, leading to markedly discernible diameter differences - the rod is not round. There can also be an adverse effect on surface transparency, the surface of the rod appearing
5 cloudy.

Reduction in extrusion speed with the aim of creating improved cooling conditions for the rod reduces manufacturing costs to values which are then commercially
10 unacceptable.

EP 1 291 160 (Fiberstars) describes the continuous coextrusion of polymeric optical fibers by first extruding a thin coating and then extruding the core of
15 the polymeric optical fiber from a crosslinkable polymer. The thin coating composed of a fluorine-containing polymer.

In conventional extrusion processes, deformation of the rods occurs as a consequence of their own weight as soon as rods with relatively large diameters are
20 produced.

It was therefore an object to provide a process for production of round rods with relatively large
25 diameters.

The object was achieved via a process for production of rods composed of transparent plastics via extrusion of
30 a plastics molding composition, characterized in that an extruded plastics molding composition is divided and plastics molding composition 1 is used to extrude a plastics tube, and the previously separated molten plastics molding composition 2 is used in parallel to
35 fill the freshly extruded tube, about 20 cm after entry into a vacuum tank calibrator, and the newly formed plastics molding is further processed as in conventional tube extrusion. A feature of the process is that, by means of support air and subatmospheric

pressure during the calibration process, the plastics molding composition 2 can be inserted into the plastics tube produced with the plastics molding composition 1.

5 Surprisingly, it has been found that the inventive process can produce round rods with large diameters with excellent optical quality and with particularly uniform cross section. There is no need for complicated downstream machining steps. The inventive process can
10 produce round rods with diameters of any desired size. It is preferable to produce round rods whose diameters are up to 200 mm, particularly preferably up to 80 mm. However, all sizes of diameter are possible, depending on the capacity of the extruder.

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The invention therefore also includes the round rods which can be produced by the inventive process.

Round rods produced by conventional processes having
20 relatively large diameter mostly have a matt surface. It has been found that the round rods produced by the inventive process have particularly good optical properties. Surprisingly, it has been found that the inventive round rods are highly transparent. The inven-
25 tive process produces streak-free round rods whose light transmittance is greater when compared with that of round rods manufactured conventionally. The inventively produced round rod is more effective than conventionally produced round rods in transporting
30 visible light. Surprisingly, it has been found that the inventive round rods have particularly uniform cross sections. The values obtained on measurement of the roundness of the inventive round rods are excellent. The inventive process can produce round rods from a
35 very wide variety of plastics. It is preferable to use polymethyl methacrylate, polycarbonate, or polyethylene, particularly preferably polymethyl methacrylate.

Surprisingly, it has been found that the inventive

process can produce plastics rods from uncolored polymethyl methacrylate whose transmittance is above τ_{D65} 85%.

- 5 The invention also provides an apparatus for production of the inventive round rods.

The apparatus is characterized in that an extruded round rod of relatively small diameter in an inner
10 extrusion die in parallel with an extruded tube of relatively large diameter using an outer extrusion die are introduced without contact, after discharge from the extruder, in a calibrator where they fuse to one another after about 20 cm, and it is preferable that
15 the extruded tube here is cooled with stabilization of shape prior to the fusion to the round rod. The ratio of the diameter of the plastics rod produced from the plastics composition 2 to that of the plastics tube produced from the plastics composition 1 can be as
20 desired. A rod:tube ratio of 1:2 is preferred. The rod:tube ratio is ideally from 6:20 to 45:50, very particularly preferably 9:20, 20:40, or 22:50.

The ratio of the length of the path of the plastics
25 composition 1 (of the plastics tube) prior to cooling with the plastics composition 2 (of the rod) to the diameter of the plastics tube is variable, and depends on throughput and surface quality.

30 Extruders are used to provide the plastics melt and are selected appropriately as a function of processing temperature, type of plastic, or throughput. A wide variety of extruders is available to the person skilled in the art, examples being: single-screw extruders,
35 vented extruders, cascade extruders or tandem extruders, high-speed extruders, planetary-gear extruders, twin-screw extruders, ram extruders.

The downstream vacuum tank calibrator is used as

heat-conditioning section (full-immersion water bath and/or blower air).

Figure 1 shows the inventive apparatus used to extrude
5 tube and rod.

The melt is extruded through the gap to give a tube. The inner die molds the melt to give a rod which, after entry into the vacuum tank calibrator after about 20 cm
10 fills the extruded tube. The plastics tube and, after a time delay, the extruded complete rod, are heat-conditioned in the vacuum tank calibrator in such a way as to achieve adequate dimensional stability. The inventive rod is then slowly cooled. It can be further
15 processed by conventional processing methods.

It possible to produce clear colorless or colored rods. It is also possible to produce round rods whose plastics composition 1 has been colored while the
20 plastics composition 2 is not colored or is differently colored, or in which the plastics composition 1 is not colored, while the plastics composition 2 is colored.

The inventively produced rods are used in the
25 fitting-out of exhibition stands and of shops (e.g. as decorative elements), in construction work (e.g. stair railings or stair supports), in the lighting industry (e.g. as lighting unit), in the furniture industry (e.g. table legs or chair legs), or in advertising
30 technology.

The examples given below are given for more detailed illustration of the present invention but are not intended to restrict the invention to the features
35 disclosed herein.

Examples

Inventive example 1

Uncolored polymethyl methacrylate pellets are melted in
5 a single-screw extruder. A tube whose diameter is 50 mm
is extruded by way of the inventive apparatus. 20 cm
after entry into a vacuum tank calibrator, the freshly
extruded tube is filled in parallel with the plastics
composition of the rod. The rod is slowly cooled. The
10 material is cut to size to give cylindrical test
specimens whose length is 180 mm. The face sides which
are perpendicular to the axis of the cylinder are
polished manually on a polishing belt.
Specimen E1

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Comparative example 1

2 cylindrical test specimens whose length is 180 mm are
produced from square rods composed of uncolored
polymethyl methacrylate. A cylindrical test specimen of
20 diameter 60 mm (C1) and a test specimen of diameter
80 mm (C2) are produced. The face sides perpendicular
to the axis of the cylinder are polished as described
in inventive example 1.
Specimens C1 and C2

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Inventive example 3

A transmittance spectrum in the wavelength range from
380 nm to 780 nm is measured to DIN 5036, using an
integration sphere. Each of the measurements was made
30 in both directions of transmission. Averages are given
calculated from 4 spectra, 2 in each of the directions
of transmission. The range of variation within the 4
measurements was $\pm 0.3\%$.

35 The results are collated in the table below:

| Specimen | τ_{D65} [%] |
|----------|------------------|
| E1 | 86.3 |
| C1 | 83.3 |
| C2 | 84.2 |

Table 1: Light transmittance for standard D65 standard illuminant

5 **Inventive example 4**

Light from a HeNe laser is passed along the axis of the cylinder of the specimens. A photograph is taken perpendicularly thereto.

10 The more inhomogeneous the material, e.g. as a consequence of contamination or density fluctuations, the brighter is its appearance in this arrangement, because of light scattering.

15 Specimen E1 exhibits the lowest level of light scattering.

The roundness of the inventively produced round rod (specimen E1) was also studied. For this, the diameter
20 was measured at 5 different cross-sectional points. The table below collates the results.

| Measurement No. | 1 | 2 | 3 | 4 | 5 |
|-----------------|-------|-------|-------|-------|-------|
| Diameter [mm] | 50.60 | 50.30 | 50.00 | 49.70 | 49.40 |

Table 2: Roundness of a round rod whose intended diameter is 50 mm

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Inventive example 5

As in inventive example 1, a tube whose diameter is 40 mm is extruded. 20 cm after entry into a vacuum tank calibrator, the freshly extruded tube is filled in
30 parallel with the plastics composition of the rod. The rod is slowly cooled. The material is cut to size to give cylindrical test specimens whose length is 180 mm.

The face sides which are perpendicular to the axis of the cylinder are polished manually on a polishing belt.
Specimen E2

- 5 The roundness of the inventively produced round rod (specimen E2) was studied. For this, the diameter was measured at 5 different cross-sectional points. The table below collates the results.

| Measurement No. | 1 | 2 | 3 | 4 | 5 |
|-----------------|-------|-------|-------|-------|-------|
| Diameter [mm] | 39.85 | 39.60 | 40.05 | 39.65 | 40.00 |

- 10 Table 2: Roundness of a round rod whose intended diameter is 40 mm